Pesticides and the Environment

by

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Introduction

It was Rachel Carson's book, Silent Spring, which ushered in a new era in 1962. Carson warned that the widespread use of pesticides would eventually destroy the biosphere, the world we live in, and us (mankind) with it. The chief damage, Carson said, was done by man-made radiation and man-made synthetic and "unnatural" chemicals. For the first time in the history of Planet Earth, she said, man is exposed to hazardous chemicals from the womb to the grave. One can say that the environmental movement, or even the "green revolution" was born with the appearance of this book.

While many have forgotten Carson's book by now, and while one should (generously) overlook a number of short-comings of that book, Carson was certainly right about her concerns over the widely-used insecticide, DDT. Contrary to industry predictions, DDT did show up in the most unlikely places. For instance, the pesticide was found in the Antarctic, where it never had been used, and in food destined for human consumption. Eventually, it turned up in the bodies of humans. Ever since then, the battle has been on, and Carson's arguments have been declared since to be, well, everything from "the best thing ever said/written" to "total trash." However, if one reads Carson's book carefully, it will become evident that she never called for a ban of all toxic agents. Basically, she asked for chemicals which would destroy unwanted pests, but would not endanger man; a tall order.

Carson also made many more points (remember: it was only 1962!), such as observing increased cancer (leukemia) in children as a result of using pesticides; pests developing resistance to pesticides; asking the question: are allowable tolerance levels in food really a protective measure, considering that these tolerances are derived for one single compound in isolation, not mixtures; and suggesting integrated pest management.

In short, and I humbly admit it, Carson wrote the basic script of what I am going to say today. So, in a nutshell, what's new, since 1962?

What is new is the following:

1. We have, finally, overcome the notion that the "environment" is something that exists apart form "us = people." The Canadian Environmental Protection Act (1987) defines environment as a total ecosystem, and calls for protection of the environment for its own sake as well as for the protection of human health. The Act places emphasis on Life-Cycle management of chemicals as the central mechanism and emphasizes prevention (over repair) of damage to the environment.

2. We have learned, the hard way, that many pesticides (or other chemicals, for that matter) that were thought to be quite safe turned out to cause adverse effects, or to behave differently than expected earlier, simply because time has allowed more subtle effects to become evident, and because our methods of assessment have become more "sophisticated" or stringent.

   Allow me to review here, very briefly, the current regulatory safeguards with respect to consumer and environmental protection. The Federal Department of Agriculture, in collaboration with the Departments of Health and Welfare, Environment, and Fisheries and Oceans, reviews the very comprehensive data package that has to be supplied by a company that wishes to register a novel pesticide. Numerous studies are required, such as acute and long-term studies in mammalian species, and environmental fate studies, including fish and other aquatic organisms, etc. The same sort of data package is needed when a registered produce is re-evaluated (for details, see Ritter and Wood, 1989).

3. The public has entered into the discussion, with the persuasive support of the media, and while not all of the discussions, or the arguments used, are valid or sufficiently backed up by facts, there is now a perception that all man-made chemicals are "really bad," and should be banned.

4. Some very prominent scientists have entered the debate by stating that nature provides plenty of very nasty compounds, often much more potent and toxic than man-made chemicals, and that life-style or habits are more likely to cause serious health damage than man-made pesticides and their use (Turnbull, 1984; Ames, 1987; Ames *et al.*, 1987).

5. Some hold the view that "safety kooks" are now jeopardizing farm practices that have enabled Canada (and other countries) to attain the high standard of living people in "developed" nations enjoy, without endangering the wellbeing of these people.

To discuss all these issues and controversies in the time allotted to me is clearly impossible. Therefore, all I can do is try to describe (very briefly) the issues as I see them as a toxicologist. I suggest we look critically at three sides (as you know, every coin has three sides, although the third one usually is not looked at very carefully).

Side #1: The First (Dark?) Side:

(1) Effects on soil microorganisms

Some hold the view that soil microorganisms are damaged seriously, or forever, by the use of pesticides (herbicides in particular). While damage to soil algae has been shown to occur, the overwhelming evidence now indicates that many bacteria thrive on herbicides. In fact, they enjoy such treatments to the point that year-after-year application of standard rates of herbicide application results in such an increase of these voracious critters that the efficacy of standard treatments is reduced considerably (which calls, promptly, for higher application rates). This fact has been elegantly, and convincingly, demonstrated in some recent papers (e.g., Laveglia and Dahm, 1977; Smith, 1989; Smith *et al.*, 1989).

(2) Negative impact on environment

There is no doubt that application of many pesticides can have a negative impact on the environment at large. Certain pesticides (e.g., pyrethroids) will kill small aquatic organisms, depriving ducks, etc., of essential food supply. This poses a real problem for aerial application, considering the many lakes, ponds and sloughs on the prairies.

Within this context, atmospheric transport of pesticides is a rather novel area of research, and some astonishing facts have come to light recently. Glotfelty *et al.* (1988) reported seasonal deposition of alachlor, atrazine and simazine *via* rainfall over three sampling sites in marshlands in Maryland (USA). Assuming uniformity of pesticide concentrations and rainfall, the estimated quantities deposited over the whole area ranged from a low of 110 kg for simazine in 1982 to almost 10 metric tons for alachlor in 1984. No matter what toxicologic significance one attaches to such deposition from a traditional viewpoint, one cannot help but wonder just what effects such, totally non-expected and non-forecasted, events will have on the environment at large.

The same applies to the atmospheric transport "closer to home," i.e., with respect to us humans. The Toxicology Research Centre receives, on an almost predictable and regular basis in the summer months, phone calls from individuals who claim that they can't drive, say, even from Regina to Saskatoon without suddenly experiencing shortness of breath and other respiratory symptoms, and they suspect that spraying of agricultural chemicals is the cause of their symptoms. While we thought first that such complaints were the result of imagination, we no longer do so, since we know that most herbicides are readily introduced into the atmospheric environment (Grover, 1990), both during and following (after rainfall) their application. On entry into the atmosphere, the herbicides are transported in the form of vapour or particulates, as a mist or aerosol of small droplets, or are associated with airborne dust. I emphasize, however, that we are probably talking about effects in a minority of people (up to 10%), but the mere fact of occurrence of this unpredicted atmospheric transport tells us that former predictions about the "safe breakdown of chemicals, at the site of application," are not quite true. Certainly, the predictions are not <u>complete</u>.

Maybe I should say something about the "up to 10% figure." It is generally assumed that 1% of the population is genetically programmed to become allergic. Such persons are called "atopic individuals." It is estimated that a further 9% is genetically predisposed to hypersensitivities. Their allergies (or better, sensitivities) may be first activated by chemicals other than agricultural chemicals. For instance, formaldehyde is a good sensitizer in some persons; in others, it may be the petroleum product series, etc. Once "sensitized," these persons react to other compounds as well.

Let's move on to effects on wildlife. With respect to other terrestrial animals (mainly mammals, but also birds, and more lowly creatures), we can only speculate to some extent, although there are at least a few (too few) studies which indicate that spraying of insecticides does <u>not</u> have the severe, or long-lasting effect, that was once predicted. For instance, a yet unpublished study under the direction of Dr. Irvine at the Toxicology Research Centre has shown that there are no catastrophic effects after spraying of the insecticide, carbofuran. However, on closer examination, it became evident that the cholinesterase levels of birds and mammals dropped by 50% after spraying. That decline does not cause death, but causes behavioral and subclinical changes, which might cause death due to predators, or inability to find food.

(3) Development of pest resistance is another, somewhat novel issue - at least to us.

From Nature's viewpoint, development of resistance is not novel, because living organisms must adapt to many new challenges or fail, or die, or lose their niche in the environment, etc.; a principle of evolution. Thus, we should not be too surprised that many pests ("unwanted forms of life") develop resistance to commonly used pesticides. That experience has, actually, two aspects. On the one hand, development of resistance is "bad news" for those who want to get rid of the particular pests, and - unfortunately - calls for the development of even more potent (more toxic?) pesticides. On the other hand, there is a silver lining to this reaction: if resistance can develop in the pests, could it be that resistance may develop in humans, too?

Rapid development of weed resistance occurs most often under a monoculture cropping system where the same crop (e.g., wheat/fallow/wheat) and the same weeds are repeatedly exposed to herbicides having the same mode of action. Resistance rarely occurs in areas where crop rotations are practised or where short residual herbicides with different modes of action are used.

(4) If the soil is dry, pesticides will not migrate very far vertically, but that pattern is reversed under irrigation conditions.

This is yet another example of how incomplete our understanding of the effects of pesticides is. Given natural conditions, meaning prairie conditions with little moisture arriving on the surface, there is little, if any, concern with respect to contamination of ground water. However, that situation is totally reversed under the often promoted method of irrigation. The usual drenching methods of irrigation will "push" pesticides into the lower levels of soil, thus creating a possibility for contaminating ground water.

<u>The Second (Bright?) Side:</u>

(1) Economic considerations

There is no doubt that all of us have benefitted from the use of pesticides. We enjoy an incredibly high standard of living, with food costs (as a percentage of disposable income) more or less constantly dropping - not that this is good news for farmers, who deserve a very fair share of income for all their efforts. Farmers are, apparently, expected to produce food at low costs, yet they are also expected to be good stewards of the land.

(2) Long-term effects: no obvious damage.

In the face of all the "doomsday-sayers," we have to ask the question: "Just where is the evidence that 'we' (all of us) are suffering from pesticide poisoning?"

It is no secret that people in countries with high agricultural chemical usage enjoy an increase of their lifespan, not a reduction. This, of course, is a correlation, not a direct cause-and-effect situation. A recent publication by Godon *et al.* (1989) tells us about effects of agricultural pesticides in Quebec for the years 1982-83, with respect to contamination of drinking water by agricultural pesticides. While the study concludes with the statement that there may be a relationship between pesticides in drinking water and leukemia (a form of

cancer of the white blood cells), the overall evidence is that there appears to be no problem. Some of this has been discussed earlier, but - as we have seen - we are far from being certain. In other words, an element of caution remains. Can we really keep on adding, without any limits, to the existing burden (both of our bodies and the environment) of chemicals?

(3) One more "bright" side: Chemical summer-fallow provides cover for ducks

Very recently, we are witnessing a totally unexpected forging of an alliance: the users of chemicals for summer-fallowing, and those interested in the welfare of ducks are uniting. Chemical summer-fallow, apparently, provides ideal cover for ducks to raise their young, in the vicinity of available ponds or marshes. This is an exciting new window that gives us the chance for a new look at the "problem" of pesticides and wildlife. The use of chemicals under such circumstances may - indeed - prove to be of benefit to waterfowl, and every effort should be made to support - or verify - such studies, because this may be a principle which might apply - with some modification - somewhere else. Of course, we have yet to ascertain that the chemicals used for fallowing don't kill the food supply in the marshes or open waters.

The Third Side (the smallest, but possibly the "right" side)

(1) Integrated pest management and alternatives have to be employed.

There are now a number of non-chemical, or "natural" methods to control pests (in the widest sense of the definition of a "pest"), and we have heard about some of them today, already. In addition, there are other rather promising methods of biological pest control, such as providing sterilized mates for one sex of the pest; selectively luring pests into traps, using their own chemical attractants (pheromones); introducing predators, parasites, bacterial or fungal diseases specific to the pest (preferably established, "natural" diseases, not "imported" ones); using allelochemicals for natural biochemical control, e.g., by "companion planting" or special green mulching. None of these methods are "one shot/one success" methods. In fact, most of these methods are typical examples of how to reduce the pests to negligible or tolerable levels, rather than eliminate them.

(2) That means: (a) use chemical pesticides only when needed; (b) use "biological" pesticides, including allelochemicals, as long as losses due to pests are within acceptable levels; (c) consider frequent crop rotation to "break pest cycles" and to avoid development of weed resistance; (d) consider employing smaller plots which will allow for natural means of pest control; (e) develop "better" pesticides, for instance, non-volatile pesticides and/or formulation.

In my opinion (and that opinion is of limited value, because I am not an agronomist), the only solution will be a really integrated method of pest control, that is flexible and adaptable, but definitely taking into account the following actions:

- employ all methods that are economically feasible and worthy to be used, without using any chemical at all, yet
- use chemicals when clearly needed, but in such cases, never use them without any "pity" for non-target "deaths,"

- have a general understanding that the environment is a very intertwined and complex system, that should not be exploited for short-term gain. Farming practices have to consider the long-term aspect, the "sustainable agricultural practice" aspect.

Conclusions

After what I have said, there is really no good reason to state specific conclusions, or some highly defined final goals. The common goal is, in my view, to achieve a prudent balance between use of chemicals (to achieve specific, targeted effects) and manageable/achievable natural control mechanisms. Or, to rephrase this (as the Crop Protection Institute of Canada said lately, 1989; 1990): "Farm chemicals should be used only when necessary...." "Chemicals are not the complete answer, so they must be used in combination with good farm management, biological controls, cultural controls and, in the future, with biotechnological control methods. Chemicals must be used only when necessary and only with strict adherence to use recommendations."

If such a flexible, integrated, and environmentally responsible approach is used, farmers (i.e., the producers) will not only come very close to achieving the goal of truly sustainable development, but producers will also put consumers (and they are, after all, the final judges for all products) into a mode of understanding that sustainable development and general health are mutually compatible, as long as both parties act and behave responsibly and can trust each other.

I think **that**, really, is the ultimate and final message of my presentation.

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